JOURNAL OF TRANSPORT

ISSUE 3, 2024 vol. 1
ISSN: 2181-2438

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RESEARCH, INNOVATION, RESULTS

TOSHKENT DAVLAT TRANSPORT UNIVERSITETI
Tashkent state transport university

JOURNAL OF TRANSPORT

RESEARCH, INNOVATION, RESULTS

ISSN 2181-2438

VOLUME 1, ISSUE 3

SEPTEMBER, 2024

jot.tstu.uz

TASHKENT STATE TRANSPORT UNIVERSITY

JOURNAL OF TRANSPORT

SCIENTIFIC-TECHNICAL AND SCIENTIFIC INNOVATION JOURNAL

VOLUME 1, ISSUE 3 SEPTEMBER, 2024

Founder of the scientific and technical journal “Journal of Transport” – Tashkent State Transport University, 100167, Republic of Uzbekistan, Tashkent, Temiryo‘lchilar str., 1, office: 465, e-mail: publication@tstu.uz.

The “Journal of Transport” publishes the most significant results of scientific and applied research carried out in universities of transport profile, as well as other higher educational institutions, research institutes, and centers of the Republic of Uzbekistan and foreign countries.

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Tashkent State Transport University had the opportunity to publish the scientific-technical and scientific innovation publication “Journal of Transport” based on the Certificate No. 1150 of the Information and Mass Communications Agency under the Administration of the President of the Republic of Uzbekistan. Articles in the journal are published in Uzbek, Russian and English languages.

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The effect of a multifunctional additive and a low-activity mineral filler on the formation of porosity and microstructure of a cement composite

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Abstract: The article examines the effect of a multifunctional additive and a low-activity mineral filler on the formation of porosity and structure of a cement composite. The multifunctional additive includes several active components that contribute to improving the properties of the cement matrix, whereas a low-activity mineral filler is used to regulate microstructure and porosity. In the course of the work, experimental studies were carried out, including the analysis of pore morphology and particle distribution using X-ray phase and differential thermal methods. Changes in the structure of the cement composite, its strength and durability were evaluated depending on the content and ratio of additives. The results showed that the combination of a multifunctional additive and a low-activity filler leads to a significant improvement in the mechanical properties and controlled porosity of the cement composite, which opens up new prospects for the development of more efficient building materials.

Keywords: complex modified concrete, non-heating technology, low-temperature technology, local raw materials, multifunctional additive, mineral filler, modification of concrete mixtures, ecology of construction

1. Introduction

In the construction industry, concrete and reinforced concrete structures are the most popular materials, both in terms of production volume and technical and economic characteristics. Concrete, recognized as the "material of the 20th century", continues to be the main construction material in the 21st century. Modern requirements for construction quality emphasize the need to use building materials that are not only low in cost and production costs, but also superior in performance to existing analogues.

In recent years, the international construction industry has seen the active development of low-energy technologies aimed at creating the "concrete of the future" using complex modifiers. This innovative approach solves current problems such as environmental safety, cost-effectiveness and rational use of resources. It also contributes to a significant improvement in the strength of concrete, reaching 70% or more in the early stages of hardening. Promising solutions include the use of complex modifiers, including polyfunctional additives and mineral fillers, which open up opportunities for the transition to resource-saving low-heating and non-heating technologies for the production of reinforced concrete products. This allows accelerating construction processes and obtaining cement composites with predetermined properties that meet modern requirements for strength, durability and environmental sustainability.

In the Republic of Uzbekistan, where the construction industry is developing rapidly, significant results have been achieved in the production of complex-modified concrete and reinforced concrete structures using highly effective additives. This has allowed not only to reduce the cost, but also to improve the quality and performance properties of cement concrete. The use of complex additives has become more effective, which is confirmed by numerous studies aimed at improving the reliability and durability of building materials. These studies help to increase the service life of structures and reduce operating costs. Practical recommendations are being developed to significantly improve the physical, mechanical and performance indicators of such materials. One of the key aspects in implementing these tasks is the improvement of existing technologies that ensure the grade strength of finished products and structures using resource-saving low-heating or no-heating methods. This is achieved through the combined use of mineral microfillers of technogenic origin and polyfunctional chemical additives. This article is devoted to the study of the effect of a polyfunctional additive and a low-activity mineral filler on the formation of porosity and microstructure of a cement composite.

2. Materials and research methods used

In the article, Portland cement CEMI 32.5N from the Akhangarancement plant was used as a binder, steelmaking waste from the Foundry and Mechanical Plant of JSC Uzbek Railways was used as a fine filler, and a new generation of highly effective superplasticizer based on polycarboxylate esters and ammonia water POLIMIXJBI and superplasticizer based on polycarboxylate esters POLIMIX from ARMENT CONSTRUCTION CHEMICALS were used as a chemical additive.

To evaluate the pore structure of cement systems, the mercury porosimetry method was used on a Thermo Sci B : Pascal 240 EVO porosimeter. This method allowed for a detailed analysis of the distribution of pore sizes, total porosity and pore structure of cement stone. The porosimetric assessment was carried out on samples maintained under standard temperature and humidity conditions, which ensured their representativeness.

Differential thermal analysis was used to study the thermal properties of cement stone and assess phase changes during hardening. Samples of cement composites containing

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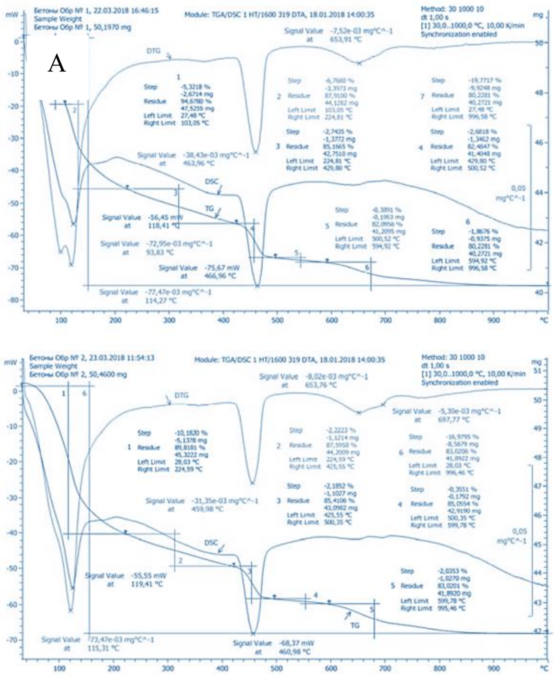
different ratios of a polyfunctional additive and a low-activity mineral filler were prepared for analysis. DTA was carried out on samples cooled and dried to a constant weight, which made it possible to determine the temperatures of the onset and end of phase changes, as well as to analyze the effect of additives on the thermal behavior of cement stone.

X-ray phase analysis was used to study the phase composition and crystal structure of cement stone. Samples for X-ray phase analysis included cement composites with various additives, which allowed us to evaluate the effect of a polyfunctional additive and a low-activity mineral filler on the formation of hydration phases. X-ray phase analysis was performed on powder samples of cement stone, which were pre-crushed to a certain particle size and placed under for X-ray analysis.

Thus, the use of the indicated research methods made it possible to comprehensively evaluate the effect of a multifunctional additive and a low-activity mineral filler on the porosity and microstructure of cement composites, providing valuable information for optimizing the composition and improving the characteristics of the cement material.

3. Results and discussions

To ensure a high strength level of modified cement stone with complex additives, a detailed study of its structure and phase changes during hardening is required. In this study, differential thermal (Fig. 1) and X-ray diffraction (Fig. 2) analysis of cement stone samples after 28 days of hardening were performed to evaluate the effect of various additives on the strength characteristics. As part of the experiment, the effect of ettringite phases at late stages of hardening was studied in samples with various additives, including fly ash (FA) and low-active steelmaking waste (LAW). The analysis was carried out for the following compositions: 1) reference composition based on Portland cement (PC); 2) PC with the addition of FA (30%); 3) PC with the addition of LAW (25%).



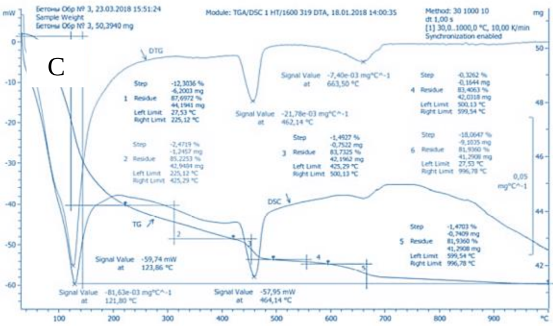


Fig. 1. Thermogram of the studied compositions. (A - reference composition from PC; B - PC+ZU (30%); C - PC+CDP (25%))

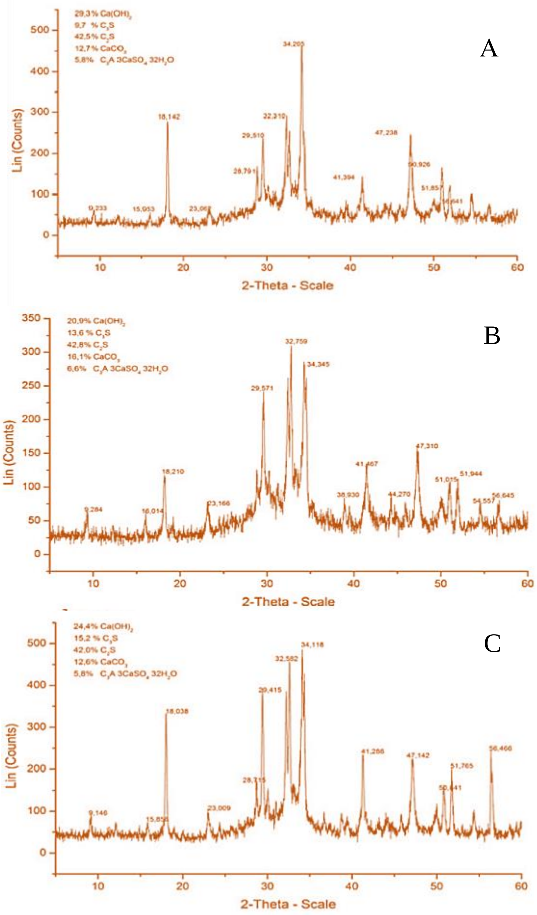


Fig. 2. Diffraction pattern of the studied compositions. (A - Reference composition from PC; B - PC + ZU (30%); C - PC + SLW (25%))

Analysis of Fig. 1 showed that the introduction of amorphous silicate into the cement composition contributed to a significant decrease in the amount of decomposing Ca(OH)2 during heating and increased the formation of new compounds due to the influence of amorphous silicon in the process of hydration of clinker cement. The greatest decrease in the amount of calcium hydroxide was observed in the modified composition with ZU, which is obviously associated with the active interaction of Ca(OH)2 with amorphous SiO2.

The analysis of diffraction patterns showed that amorphous silicate additives reduce the intensity of Ca(OH)2. In the control sample (Fig. 2A), the content of

Ca(OH)2 was ~29.3%, and in composition No. 3 - ~23.7%. In the modified compositions with fly ash, an increase in the ettringite phase was observed from 5.8% to 6.6% due to a decrease in alkalinity and the formation of hydrosulfoaluminate minerals. This trend consists of a decrease in the content of Ca(OH)2 in the modified compositions compared to the standard, although in the compositions with FA the content of bound Ca(OH)2 is somewhat higher than in the samples with SLW.

In our opinion, this is not a disadvantage, since the decrease in the content of Ca(OH)2 does not lead to a significant decrease in the alkalinity of the cement stone and, as a result, the protective properties in relation to steel reinforcement in concrete increase significantly. Moreover, maintaining the required level of alkalinity of the pore fluid also helps to increase the resistance of the composite to sulfate and carbonation corrosion.

Numerous studies of the physical and mechanical properties of concrete, such as strength, deformability, permeability and frost resistance, have established a significant dependence of these characteristics on the size, configuration and number of pores in the material.

To study the porous structure of the studied compositions given in Table 4, studies were conducted using a Thermo Scientific Pascal 240 EVO mercury porosimeter (Table 1).

Studies of the porous structure of the compositions showed that the introduction of a complex additive affects the change in concrete porosity. In particular, the total porosity of composition No. 3 decreased by 20.25% compared to the control sample. The most significant decrease in porosity was recorded in composition No. 2, where the porosity of the modified composition based on NFA and SLW decreased by 30.11% compared to the control sample.

Comparison of the porous structure of different concrete compositions showed that the best reduction in all porosity indicators was observed in composition No. 2.

Operation of building structures at variable temperatures, including positive and negative values, leads to a decrease in the strength characteristics of heavy concrete due to thermal deformations and changes in the internal structure. One of the key factors affecting the durability of concrete is porosity. High porosity promotes water absorption, which increases the likelihood of damage during freeze-thaw cycles. Concrete with low porosity demonstrates better resistance to such effects.

Table 1

Indicators of the porous structure of the studied compositions

Name of indicators	Compound №1	Compound №2	Compound №3
Specific pore volume (mm^3/g):	63,81	46,78	49,24
Total pore area (m^2/g)	6,576	4,908	5,112
Average pore size (mkm):	0,0388	0,031	0,035
Total porosity of samples, %	14,91	10,42	11,89

4. Conclusion

X-ray diffraction and differential thermal analysis of the studied cement composites confirmed that the use of a complex modifier promotes enhanced hydration processes and the formation of high-strength calcium hydrosilicate compounds, which is associated with the effective binding of mineral calcium hydroxide with amorphous silicate. These changes lead to improved physical and mechanical properties of cement stone. In addition, it was found that the use of low-active SLW prevents the formation of the ettringite phase by maintaining a certain level of alkalinity in the cement composite. These results indicate that complex additives can significantly improve the performance characteristics of cement stone and contribute to its more stable and durable behavior. Analysis of the porosity indices of the studied cement composites demonstrated a significant decrease in the total porosity in the complex-modified composition. In particular, the total porosity of the reference composition decreased by 30.11% compared to the control composition, while the specific volume decreased by 26.68%. These results indicate an improvement in density and a decrease in porosity due to the use of modifiers. In comparison with the composition based on POLIMIX and SLW, the total porosity and volume porosity indicators were 12.3% and 4.9%, respectively. These data confirm the high efficiency of using NFA and SLW in reducing porosity and improving the structural properties of cement composites.

References

[1] Адилходжаев, А., Шаумаров, С., & Кандахаров, С. (2022). IMPROVING THE PHYSICAL AND MECHANICAL CHARACTERISTICS OF STRUCTURAL AND HEAT-INSULATING AERATED CONCRETE. Научный журнал транспортных средств и дорог, 2(2), 131-136.

[2] Адилходжаев, А. И., Махаматалиев, И., Кадиров, И., Азимов, Д. Т., & Кудратов, Б. (2023). Теоретические и методологические аспекты получения и применения минеральных порошков в качестве наполнителей для цементных систем. Недропользование и транспортные системы, 13(1), 30-39.

[3] Ishanovich, A. A., Kadirov, I. A., Sherzodovich, K. B., & Farkhadovna, T. D. (2023). ON CARBONATION CORROSION OF MODIFIED CONCRETES USING MICROWAVES. Miasto Przyszłości, 40, 639-342.

[4] Adilkhodzhaev, A. I., Kadirov, I. A., & Kudratov, B. S. (2023). To the Question of Optimization of the Process of Mechanical Activation of Metallurgical Slag.

[5] Тургунбаев, У., Кудратов, Б., & Тухтабоев, Э. (2022). DISPERSED REINFORCEMENT OF NON-AUTOCLAVED AERATED CONCRETE WITH ASBESTOS AND FIBERGLASS: DISPERSED REINFORCEMENT OF NON-AUTOCLAVED AERATED CONCRETE WITH ASBESTOS AND FIBERGLASS. Ресурсосберегающие технологии на транспорте, 2022(2022), 384-388.

[6] Адилходжаев, А. И., Кадиров, И. А., Абдуллаев, У. Х., & Кудратов, Б. Ш. (2022). О влияние комплексных-модифициров с наполнителями различной природы на свойств тяжелого бетона.

[7] Adilkhojaev, A. I., & Kadirov, I. A. (2021). On the Mechanoactivation of Metallurgical Waste. European Journal of Research Development and Sustainability, 2(5), 60-67.

[8] Adilxodjaev, A. I., & Kadirov, I. A. (2023). Expanded Clay Concrete Made on the Basis of Metallurgical Waste.

[9] Adilkhodzhaev, A. I., Kadirov, I. A., Umarov, K. S., & Azimov, D. T. (2023). To The Question of the Choice of Technological Equipment For Continuous Shell less Forming Reinforced Concrete Products on a Long Stand. EUROPEAN MULTIDISCIPLINARY JOURNAL OF MODERN SCIENCE (EMJMS), 1.

[10] Ishanovich, A. A., & Abdullaevich, K. I. (2021). Technical And Economic Comparison Of The Efficiency Of Production Of Empty Plates Of Overlapping Of Underworking Forming When Reinforced With Wire And Ropes. European Scholar Journal, 2(11), 66-69.

[11] Adilkhodzhaev, A. I., Kadirov, I. A., Umarov, K. S., & Azimov, D. T. (2021, October). Features of continuous units forming of reinforced concrete products. In " ONLINE-CONFERENCES" PLATFORM (pp. 1-4).

[12] Adilkhodzhaev, A. I., Umarov, K. S., Kadirov, I. A., & Azimov, D. T. (2021, September). Modern Resource-Saving Technologies for Production of Pre-Concrete Concrete Structures. In " ONLINE-CONFERENCES" PLATFORM (pp. 86-89).

[13] Nazarova, S. B., Adilxodjaev, A. I., & Kadirov, I. A. (2021, June). LIGHTWEIGHT CONCRETES BASED ON POROUS AGGREGATES. In E-Conference Globe (pp. 134-136).

[14] Adilkhodzhaev, A., Makhamataliev, I., Umarov, K., & Shaumarov, S. (2020). On the method of ensuring the quality of concrete mix and concrete on the lines of formless molding of reinforced concrete products. Solid State Technology, 63(6), 414-420.

[15] Махаматалиев, И. М., Цой, В. М., & Кадыров, И. А. (2019). Современные методы исследования поровой структуры строительных материалов. Учебно-методическое пособие. Адылходжаев АИ.

[16] Adilkhodjayev, A. I., & Kadirov, I. A. (2018). SOME ASPECTS OF STUDYING THE STRUCTURE OF CONSTRUCTION MATERIALS BY THE METHOD OF MERCURY PUROMETRY. Journal of Tashkent Institute of Railway Engineers, 14(2), 3-7.

[17] Adilxodjayev, A. I., Kadirov, I. A., & Abdullayev, U. X. ABOUT THE PROPERTIES OF A MODIFIED CEMENT BINDER BASED ON A BINARY MICROWAVE. THE SCIENTIFIC JOURNAL OF VEHICLES AND ROADS, 112.

[18] KadyrovIlkhom, A., & Said, S. UmarovKadir. Some Peculiarities of the Process of Preparing the Zeolites Containing Breeds in a Ball Mill. International Journal of Recent Technology and Engineering (IJRTE). Issue-4, 7695-7698.

[19] КАДЫРОВ, И. ЦЕОЛИТСОДЕРЖАЩИЕ ПОРОДЫ УЗБЕКИСТАНА И ПЕРСПЕКТИВЫ ПРИМЕНЕНИЯ В ЦЕМЕНТНЫХ КОМПОЗИТАХ. Р е ц е н з е н т ы: генеральный директор РУП «Гомельавтодор» СН Лазбекин; д-р техн. наук, профессор АК Головнич (БелГУТ), 42.

[20] Адилходжаев, А. И., Игамбердиев, Б. Г., & Сон, Д. О. (2024). К ВОПРОСУ ИСПОЛЬЗОВАНИЯ НЕКОНДИЦИОННОГО СЫРЬЯ ПРИ ПРОИЗВОДСТВЕ КЕРАМИЧЕСКИХ КИРПИЧЕЙ. Universum: технические науки, 2(7 (124)), 18-22.

[21] Адилходжаев, А. И., Кадиров, И. А., Азимов, Д. Т., & Кудратов, Б. Ш. (2023). НЕКОТОРЫЕ АСПЕКТЫ ТЕХНОЛОГИИ НЕПРЕРЫВНОГО БЕЗОПАЛУБОЧНОГО ФОРМОВАНИЯ ЖЕЛЕЗОБЕТОННЫХ ИЗДЕЛИЙ. In Актуальные проблемы современной науки, техники и образования (pp. 17-17).

[22] Adilkhodzhaev, A. I., Kadirov, I. A., Azimov, D. T., & Kudratov, B. S. (2024, March). Thermodynamic analysis of mineral powder grinding processes. In AIP Conference Proceedings (Vol. 3045, No. 1). AIP Publishing.

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